

Feature Detection and Analysis of Pigeon Peas Using Image Processing

Suma M^{#1}, M P Indra Gandhi^{*2}

[#]Department of computer science, Mother Teresa Women's University
Kodaikanal, Tamil Nadu, India

¹sumaimpu@gmail.com

^{*}Department of computer science, Mother Teresa Women's University
Kodaikanal, Tamil Nadu, India

²mpyazhini@gmail.com

Abstract— Image processing is one of the challenging areas in computer science which finds its application and place in almost every area of research. Pigeon peas, which are popularly called as Toor dal in India, is widely used as one of the main ingredients in food globally, as it is rich in proteins. One of the challenges faced by the food industry is in assessing the quality and the type of the grains and pulses. The quality detection by manual inspection in analysing the grains and pulses may not give accurate results compared to an automated system. For a common man, the colour, size and texture of dals are important parameters in deciding their quality. But in some cases, more the colour lesser the quality as the dals may be polished. This paper focuses on developing a model which can extract the geometrical features and analyses in classifying pigeon peas into different groups. Digital samples of both polished and unpolished pigeon peas are taken for analysing and classifying them based on three parameters: size, colour and texture. The images are processed using matlab, a software tool.

Keywords— *Toor dal, feature detection, image analysis, size, colour pixel intensity, RGB colour detection, texture.*

I. INTRODUCTION

Toor dal, scientifically named as *Cajanus Cajan*, Pigeon Pea belongs to the family of pulses. In India, we call it as Arhar or red gram[1]. We find its presence and use in our daily food culture as it is very rich in proteins. It can be called as a staple food in Indian food habits as it is used as one of the main ingredients in cooking sambar (lentil soup). The agriculture industry faces many challenges and problems as it has to keep growing the quality food which may include vegetable, fruits, grains and pulses. The manual inspection becomes cumbersome, tiring and consumes lot of time and it may also affect and disturb the farmers in their day-to-day activities and also there is a possibility that detection may vary from person to person[3]. Therefore, it is important to develop an automated system which can identify and assess the food grown by farmers in agriculture fields.

Digital image processing is constructive in giving accurate outputs for any type of digital image. We manually grade the pigeon peas quality by looking at their size, colour and texture. So to develop a machine vision system to execute this pattern recognition (size, colour and texture) on the dals can be done by making use of techniques available in image processing. The size of dals can be measured by using the concept of morphological processing, while colour identification can be done by RGB colour processing, and dals' texture can be checked by using the texture features. After taking the digital image of the samples, the region of interest that is dal is identified by detecting the edge from the image after converting into a binary image. Then the colour of dals is determined by taking the intensities of red,

green and blue colours in each of the dal sample. The texture feature is checked by taking the parameters of contrast, correlation, energy and correlation and homogeneity measurement values. The pulse quality depends on various other factors like its growing habitat which may depend on soil quality, rainfall and other agriculture/ growing practices, The suitable weather conditions for Tur dal needs a moist and moderately less temperature between 20 and 25 degree Celsius during its vegetative growth and moderately high temperature of 30 to 35 degree Celsius during its maturity period. However, the quality can also be affected by heavy rain and hailstorm which may damage the entire crop.

II. PROBLEM DEFINITION

The objective of this paper is to develop an automated machine vision system to identify and classify dal samples based on their geometrical features which describe their size in terms of area of dal, colour identification based on the intensities of RGB components present in the sample dal, and the texture features which describe their softness, randomness and roughness. For analysing and classifying pigeon peas, we have taken digital images of both polished and unpolished sample dals grown in different regions[5]. The samples, identified as sample1, sample2, sample3 and sample4 (each set comprising 20-30 dals), have been classified into first-quality dal and second-quality dal based on their size, colour and texture.

III. PROPOSED MODEL

The proposed model classifies dal samples into two categories based on the following three parameters.

1. Size
2. Colour
3. Texture

We have divided the model into three units where unit I calculates the size of dals, unit II measures the RGB colour components and unit III checks the textural values.

UNIT I PIGEON PEA SIZE DETECTION

The first step in automating this model is to capture the images of pigeon pea samples, and this can be done by image-acquisition process. A digital camera of 12 MP is used to take the pigeon pea sample images in the presence of natural sun light. Dals were spread uniformly on a plain white sheet of paper. We made sure that the dals were not in contact with one another. The images were acquired and stored in JPEG format. All the sample images are resized to 256 by 256 pixels. The captured images are shown below. After the images are acquired, they are enhanced to highlight the features of interest in them.

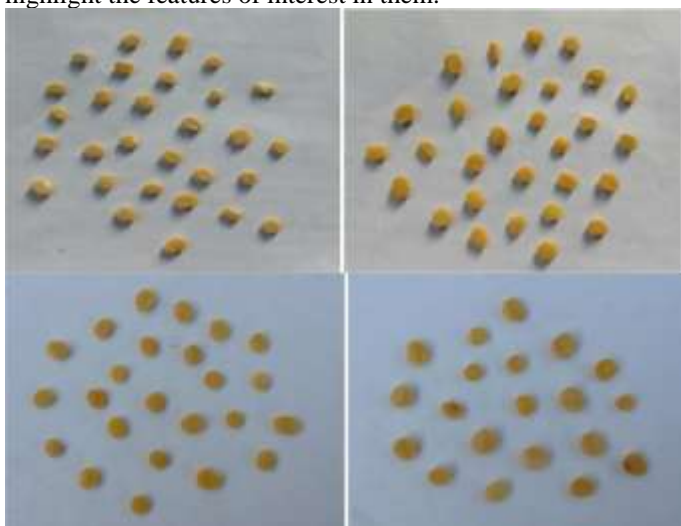


Fig. 1. A. Sample1, B. Sample2, C. Sample3, D. Sample4

From the images that were acquired, our area of interest is pigeon peas that are spread uniformly on the sheet of paper. To identify the pigeon peas, these images are converted to a gray scale image by taking the gray threshold values[6]. Then the images are converted into a binary image with clearly identifiable objects, because it becomes easy to process a binary image than a colour image[7]. To remove any holes in the image use morphological operations such as imfill function of matlab which fills the holes if there are any in the image and also use imclearborder function to clear any extraneous objects present in the border of the image. There are chances that image may contain objects which may have a group of noisy pixels which may resemble dals. They have to be removed so that there are

only dal objects present in the image, and we can do this by using bwareaopen function of matlab which removes all connected components (objects other than dals) that have fewer than p pixels, producing another binary image resulting in only dal grains in the image. The default connectivity used is 8. We have to arrive at a solution where the dal regions are separated from the background pixels. This can be done by measuring the pixel intensities of dals based on the pixel connectivity, which groups all pixels in a connected component which share closely related pixel intensity values and in some way the pixels are connected with each other. The different types of connectivity available for 2-dimensional images are 4-connected neighbourhood and 8-connected neighbourhood; for 3-dimensional images are 6-connected neighbourhood, 18-connected neighbourhood and 26-connected neighbourhood. So by using the bwconncomp function of matlab for the binary image with 4-connectivity neighbourhood the function returns a structure of four set of values giving the information about the connectivity, image size of binary image, number of connected components (count of dals) and pixel index list containing cell array of pixels in each of the dals are counted from the image. The labelmatrix function of matlab which takes a connected component (CC) as a parameter returns an integer value greater than or equal to 0. The pixels labelled 0 are the background and the pixels labelled 1 make up the dal objects. The fig 2 shows the binary image where the dals are detected and numbered. now we have separated our region of interest from the background and we can find out the geometrical features and calculate the size in terms of area of dals. We can classify the dals based on its size. Table I given below shows the areas calculated for the samples.

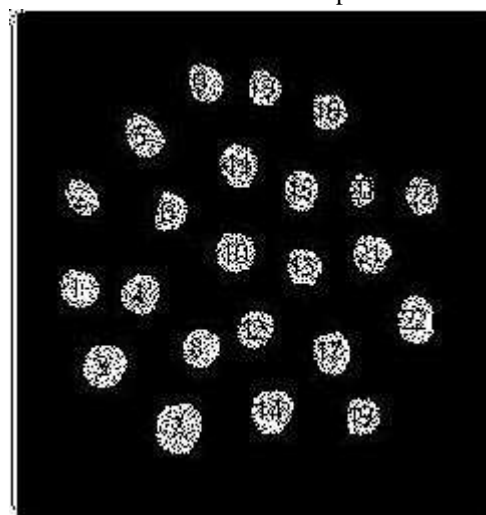


Fig 2. Binary image with dals being labelled

TABLE I
 SIZE OF DAL'S (AREA)

SI NO	SAMPLE 1	SAMPLE 2	SAMPLE 3	SAMPLE 4
1	113	273	276	366
2	112	358	231	407
3	115	373	282	353
4	85	232	350	349
5	112	321	280	264
6	111	420	251	215
7	117	251	313	211
8	104	262	200	533
9	97	287	309	385
10	130	253	307	326
11	95	164	233	237
12	94	335	295	304
13	126	336	280	518
14	118	210	287	436
15	114	265	344	462
16	133	270	260	509
17	120	221	447	520
18	117	297	234	345
19	79	215	268	710
20	69	169	223	243
21	93	192	221	948
22	128	265	207	
23	100	238	320	
24	93	258	377	
25	103	296	83	
26	84	308		

The colour of pigeon peas depends on various conditions like the soil type, climatic conditions and also post-harvest processes like polishing, so all these factors play an important role in the colour of pigeon peas. Following tabulation (TABLES II & III) gives the colour measurements of sample pigeon peas.

TABLE II
 COLOUR MEASUREMENT OF SAMPLES 1 & 2

SI NO	SAMPLE 1			SAMPL E 2		
	RED	GREE N	BLUE	RED	GREE N	BLUE
1	255	38	0	255	231	0
2	255	45	0	255	24	0
3	255	23	0	255	0	0
4	255	248	0	243	255	75
5	255	45	0	180	114	0
6	255	53	0	255	0	0
7	255	8	0	129	255	29
8	255	180	0	226	255	2
9	255	23	0	253	197	0
10	255	8	0	255	255	24
11	255	105	0	231	255	240
12	255	158	0	246	80	0
13	165	0	0	255	78	0
14	255	173	0	255	255	129
15	255	180	0	126	250	0
16	195	0	0	255	238	0
17	255	0	0	255	255	102
18	255	30	0	153	172	0
19	143	0	0	255	255	117
20	240	0	0	138	255	228
21	255	8	38	249	255	172
22	218	255	113	198	250	0
23	143	255	0	255	255	61
24	255	188	0	194	255	12
25	180	0	0	243	175	0
26	255	135	0	255	146	0
27	255	188	0	255	36	0
28	255	113	0	255	151	0
29	255	255	0	155	255	100

UNIT II

COLOUR INTENSITY MEASUREMENT OF PIGEON PEAS

An RGB colour image is a R*C*3 array of colour pixels, where each colour pixel is a triplet representing red, green and blue components of a colour image. Any colour image is a stack of three gray-scale images that, when fed into the red, green and blue inputs of a colour monitor, produces a colour image on the screen. There are different classes which determines their range of values, if it is double type then the range of values is [0,1], if they are unit8 or unit16 then the range of values are [0,255] or [0,65535]. The number of bits used to represent the pixel values determines the bit depth of a colour image.

In this unit we are measuring the colour intensities of each of the four sample sets. Colour components of each dal have to be calculated with its red, green and blue composition. In unit I we have identified the dals and labelled it, as can be seen in Fig 2. But here, each dal is a binary image with value zero as it is separated from background which is with the value 1. Now each binary sample dal has to be converted into a colour dal sample, we can do this by using label2rgb function of matlab and passing an array of dal areas as argument which was calculated in unit I. The results obtained will be a composition of colour intensity measurements of all dal samples present in the image.

TABLE III
 COLOUR MEASUREMENT OF SAMPLES 3 & 4

SI NO	SAMPL E 3			SAMPL E 4		
	RED	GREE N	BLUE	RED	GREE N	BLUE
1	246	255	9	11	255	244
2	143	255	112	55	255	200
3	255	250	0	0	252	255
4	255	96	0	0	247	255
5	255	255	0	0	156	255
6	189	255	66	0	103	255
7	255	180	0	0	99	255
8	73	255	182	190	255	65

9	255	189	0	31	255	224
10	255	194	0	0	223	255
11	148	255	107	0	127	255
12	255	221	0	0	199	255
13	255	255	0	174	255	81
14	255	239	0	86	255	169
15	255	109	0	114	255	141
16	209	255	46	165	255	90
17	130	0	0	176	255	79
18	150	255	105	0	243	255
19	228	255	27	255	129	0
20	125	255	130	0	133	255
21	121	255	134	128	0	0
22	89	255	166			
23	255	164	0			
24	255	34	0			
25	0	61	255			

UNIT III
 TEXTURE DETECTION

The appearance of pigeon peas plays an important aspect for a consumer as its surface may look smooth or rough depending on its post-harvest processes like polishing to give them a smooth texture. Or they may not be polished at all, giving them a rough texture. Texture detection in image processing can be done by segmenting the region of interest from an image. Texture properties like smoothness, roughness and coarseness are calculated statistically based texture of dals in an image as a set of primitive texels in some regular pattern. A texel, texture element or texture pixel is the basic unit in a texture map. Textures are represented by arrays of texels representing texture space.

In this unit, we are analysing the dal texture by characterizing them based on roughness, smoothness or bumpiness, which are measured on the basis of variations in the intensities of gray level pixels. There are different statistical measures available to analyse the image texture, and they are listed below.

Entropy: It measures the randomness in an image. Gray-level co-occurrence matrix (glcm): It creates a gray-level co-occurrence matrix from an image by calculating how frequently a pixel with gray-level intensity value *i* occurs horizontally adjacent to a pixel with value *j*.

The texture description resulted from glcm can be detected by choosing appropriate position operators and analysing the elements from glcm, the descriptors obtained are contrast, correlation, energy and homogeneity. The textures of sample sets of pigeon peas are calculated by generating gray-level co-occurrence matrix using the function graycomatrix function of matlab, and obtaining gray level properties which describe contrast, correlation, energy and homogeneity of pixels using graycoprop function of matlab. Table below has the statistical measurement of these values tabulated for all the sample sets of pigeon peas.

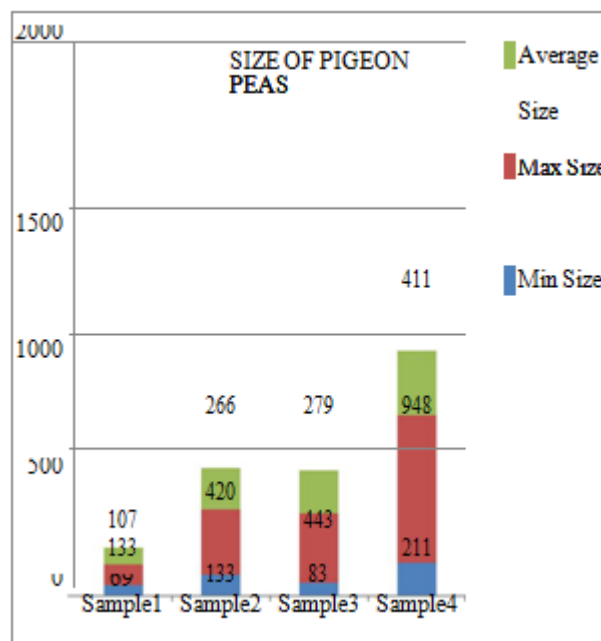
TABLE IV
 TEXTURE DESCRIPTORS

	Contrast	Correlation	Energy	Homogeneity	Entropy
Sample 1	0.0980	0.8671	0.3861	0.9510	5.3487
Sample 2	0.0439	0.9497	0.5773	0.9781	5.7040
Sample 3	0.0622	0.8858	0.5085	0.9689	5.5153
Sample 4	0.0546	0.9179	0.4492	0.9727	5.7469

IV. RESULT ANALYSIS

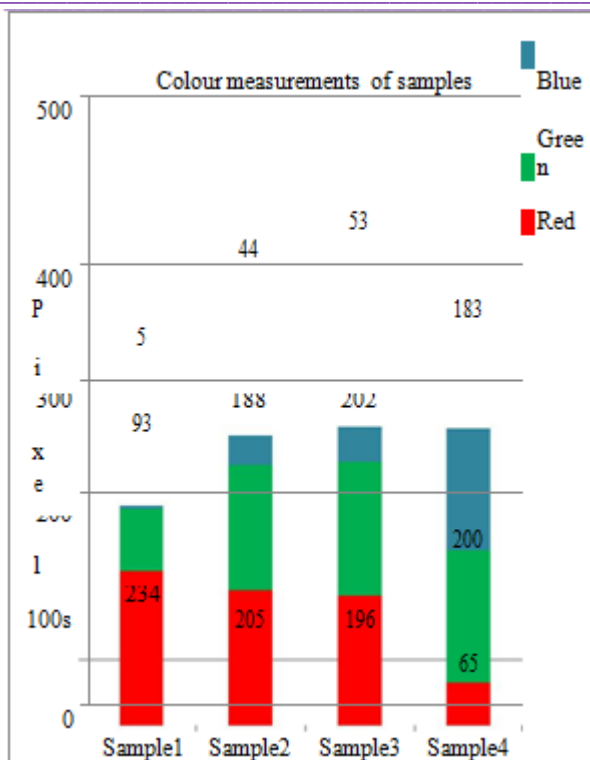
We will analyse the results based on the statistics obtained from three units based on size, colour measurement and texture of sample sets. From TABLE I, we see that the sample4 showing inconsistency in size of each dal with lowest area being 211 and highest being 948, and the average size being

411. Similarly by evaluating other sample sets, we can analyse that sample1, 2 and 3 showing consistency with reference to size of each dal.



Graph1. Showing the mean calculations from TABLE I.

Considering the colour intensities of red, green and blue components present in the sample sets, we see that sample4 showing lot of variations when compared to other sample sets, with relatively low red pixel intensity and high blue intensity values.



Graph2: Showing mean calculations from TABLES II & III.

The randomness in the dal surfaces was measured in table IV with gray-level co-occurrence property descriptors with entropy representing the randomness of the sample sets, from these values we can analyse that sample2 and 4 showing comparatively more randomness. From the above set of values, we are grouping the pigeon pea samples into first and second category and also there is a confusion in deciding sample2 and 3 because the values look almost the same. so we will put it under ambiguity.

TABLE V. RESULTS

Samples	No of samples	Grading
Sample1	29	First quality
Sample2	29	Ambiguity
Sample3	25	Ambiguity
Sample4	21	Second Quality

V. CONCLUSION

Image-processing techniques can be used in extracting the features from pigeon peas and analysing them with values obtained. Similar techniques can be applied to other food grains produced in the agriculture field and also it can be extended to seed quality detection which will help the farmers in choosing the quality seeds for sowing. Matlab tool can be extensively used to process the images. The work can be extended to more number of sample sets of pigeon peas grown in different parts of the world under various climatic conditions.

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